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RESULTS OF THE USE OF CONCENTRATED SPRAYS IN CITRUS GROVES IN FLORIDA[1]

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During the late spring and summer of 1947, grasshoppers of the species *Schistocera americana* (Drury) inflicted damage on citrus groves in western Polk and southeastern Hillsborough counties in Florida. The outbreak and recommendations for grasshopper control in citrus groves were reported by Griffiths *et al* (1947), who recommended three insecticides: chlordane at 1½ to 2 lbs. of technical chlordane per acre, chlorinated camphene at 3½ to 4½ lbs. of toxicant per acre, and benzene hexachloride at 0.4 to 0.5 lb. of gamma isomer per acre. All three materials were used as dusts and as wettable powders. Chlordane and chlorinated camphene were also tried as emulsions. As dusts they were distributed both by airplane and by ground equipment, while as sprays, they were applied with a "Speed Sprayer." The "Speed Sprayer" is a power machine in common use in citrus groves in Florida. It delivers the spray under low pressure through a large number of nozzles into an air stream which is set up by a large fan. The sprayer is capable of delivering enough air volume to completely replace the air in and around a tree with new air. Leaves throughout the tree are turned over and thorough coverage is obtained if the sprayer is driven slowly enough and sufficient gallonage is used. Usually the sprayer is pulled through the grove at about 1½ to 2 miles per hour.

[1] The authors wish to take this opportunity to thank Mr. A. C. Brown and Mr. H. S. McClanahan of the Florida State Plant Board for their help and suggestions in carrying out these experiments.

[2] Entomologists with Florida State Plant Board and Florida Citrus Experiment Station, respectively.

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During recent months considerable experimental work has been reported on the use of concentrated sprays on various crops. It appeared possible that concentrated sprays might be feasible for grasshopper control in citrus grove land. Since two different machines were available to the Citrus Experiment Station, they were tested for grasshopper control.

The Bureau of Entomology and Plant Quarantine (United States Department of Agriculture) furnished a modified Buffalo Turbine spray and dust machine. This machine had been redesigned by the Bureau as a spray machine for use in Japanese beetle control work in the eastern United States. It was capable of handling either wettable or emulsifiable materials at concentrated levels. Basically, it consisted of a pump and turbine blower. The fluid was pumped from two nozzles into the air stream under a pressure of 30 lbs. per square inch and distribution of the insecticide was dependent upon the air volume coming from the blower. In the experiments reported below two nozzles with 0.54 in. openings were used to deliver 10 gallons of emulsion per acre.

The other machine was a Hession Microsol Generator. It was built to deliver aerosol size particles into an air stream set up by a fan and was designed for use with either emulsions or solutions. In the experiments described below, it was set to apply 10 gallons of emulsified spray per acre.

Two experiments were performed in citrus groves with these machines in August and September 1947. In both instances the spray machines were mounted on trucks which were driven at 2 to 3 miles per hour up and down each middle. The spray was directed at the lower 6 to 10 feet of the trees and at the cover crop, but no effort was made to cover the tops of the trees. Both groves were heavily infested with fourth and fifth instar nymphs.

In the first experiment, technical chlordane and chlorinated camphene were used as concentrated emulsions. With the modified Buffalo Turbine machine, chlorinated camphene was used at the rate of 4.5 lbs. of toxicant (derived from a 70% stock emulsion) per 10 gallons of emulsion, and chlordane (40% stock emulsion) was used at 1.5 lbs. of technical chlordane per 10 gallons of emulsion. These were compared with 1.5 lbs. of chlordane (40% stock emulsion) per 10 gallons of emulsion applied with the Hession Microsol generator. In addition, a chlorinated camphene dust was included as a standard grasshopper treat-

ment. It was dusted with a conventional ground duster at 45 lbs. per acre of a 10% material (4.5 lbs. toxicant per acre). All plots were one acre in size and unsprayed acre plots served as buffers between treated plots. Results are summarized in Table 1.

In the second experiment chlordane was used with both machines at 1½, 2, and 2½ lbs. of technical chlordane per acre. As in the previous test, 10 gallons of emulsion were applied per acre. Plots were randomized in single acre plots which were adjacent to each other. Accurate pre-population counts were not made, but there was apparently a uniform population throughout the treated areas. Twenty-four and seventy-two hours after the applications, estimates of control were made. These were based on a comparison of the number of live grasshoppers remaining in the treated areas. Although dead individuals were present in all plots, the best treatment was obtained with 2½ lbs. of chlordane per acre distributed by the Buffalo machine. In general, it took an additional ½ lb. of toxicant per acre for the Hession machine to equal the Buffalo Turbine. This is in agreement with the data presented in Table 1.

These two experiments represent the first field scale trials of concentrated sprays on citrus trees by the Citrus Experiment Station in Florida. Although they demonstrated that grasshoppers could be controlled with such equipment, they also demonstrated certain weakneses which would appear to be inherent in concentrated spray equipment.

In order to produce satisfactory control of most insects on a citrus tree, it is absolutely essential that thorough coverage of leaves be obtained. Thorough coverage implies the application of insecticide to both sides of the leaves and to the wood where insects may be found. Where properly used, conventional grove sprayers are capable of this type of coverage. Thus, where a "Speed Sprayer" was driven at the proper speed (less than 2 miles per hour), but where only 10 gallons were used on a tree that required twice that much, it was found that the insecticide was applied only to the leaves on the outside of the tree. This was in spite of the fact that at this speed there was more than ample air volume available to replace all the air inside the tree. However, there was not enough fluid volume to cover first the outside and then the inside foliage of the tree. This phenomenon demonstrates the inherent disadvantage of the use of a concentrated spray material. Actually, it is impossible to spread as

little as 10 gallons of a liquid evenly over the entire leaf surface presented by an acre of citrus. An equal amount may be applied per tree, but this will be represented by small droplets of insecticide on a relatively small number of leaves. This type of distribution controlled grasshoppers and it is conceivable that it would also control insects such as the southern green stink bug or the leaf-footed plant bug (*Leptoglossus gonagra*) on citrus. However, these are large, free moving insects and the control of such forms as purple scale, citrus red mites, rust mites, etc. presents an entirely different problem. They would not be controlled unless insecticide thoroughly covered all of the leaves and twigs. Therefore, lack of complete coverage would appear to eliminate the use of concentrated sprays for routine grove spraying. Since conventional dusters and sprayers do as good or a better job than the concentrated spray machines used on grasshopper control, and since the concentrated spray equipment does not appear adaptable to other types of insect control on citrus, it may be concluded that, as now constructed, such equipment has no place in the citrus pest control program.

TABLE 1.—NUMBER OF GRASSHOPPERS[1] BEFORE AND AFTER TREATMENT WITH INSECTICIDES.

Type of Machine	Toxicant	Lbs. Toxicant per acre	Before Spray	After Spray
Buffalo Turbine	Chlorinated camphene	4.5	130	4
Buffalo Turbine	Chlordane	1.5	142	20
Hession	Chlordane	1.5	95	27
Duster	Chlorinated camphene (10% dust)	4.5	89	1
Untreated (Avg. of 5 plots)	----------	-------	114	63

[1] All counts based on 100 sweeps of insect net per plot.

SUMMARY AND CONCLUSIONS

In the summer of 1947 two concentrated spray machines were tested for the control of the grasshopper, *Schistocera americana* (Drury), in citrus groves in Florida. The equipment is described and the results of two experiments are presented. The machines demonstrated fair to good control where chlordane (1½ to 2½ lbs. per acre) and chlorinated camphene

(4.5 lbs. per acre) were used at 10 gallons per acre of a concentrated emulsion. It is concluded that although these types of equipment offer some possibility for the control of insects such as grasshoppers in a citrus grove, there are certain inherent defects which prevent them from practical or general use in groves.

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AN ANNOTATED BIBLIOGRAPHY OF NORTH AMERICAN THYSANOPTERISTS: PART I

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Since Fitch described *Leptothrips mali* in 1855, numerous American entomologists have added many new species of thrips to this order. The reviews and catalogs of Hinds, 1902, Moulton, 1911, and Watson, 1923 are well known. During the past forty years Hood has published about 129 papers on thrips and Moulton approximately 73 titles. These authors also have compiled many useful keys, catalogs and reviews of various groups of thrips which largely remain in manuscript. The difficulty of publishing large monographs or finding outlets for long papers is well known. One of the solutions to this problem appears to be the publishing of reviews, compilations, keys, and catalogs in parts or logical natural or related groups. Therefore, for the convenience of present and future systematic Thysanopterists we are presenting this annotated bibliography. With the exception of the works of Hood, Moulton, and Watson,[1] the authors are listed alphabetically with the species each described and the most recent published synonymy known to me.

The synonymy of other species of thrips described by North American entomologists previous to 1900 was reviewed by Hinds, 1902. Certain invalid species, not listed below, are *Limothrips tritici* Packard, 1872, *L. poaphagus* Comstock, 1875, *Thrips alii* Sirrine and Lowe, 1894, and *T. adonidum* Cook, 1873-74. In assembling this bibliography, Dudley Moulton and J. C. Crawford have supplied several references unavailable to the writer.

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Stomatothrips brunneus J. C. Cwfd., 1940a. No. Amer.
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Pseudothrips Hinds, 1902. Genotype: *P. inequalis* (Beach).

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Scolothrips Hinds, 1902. Genotype: *Scolothrips sexmaculatus* (Perg.).

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Cercyothrips striatus Morgan, 1925a. Puerto Rico.

Diceratothrips wolcotti Morgan, 1925a. Puerto Rico.

Echinothrips americanus Morgan, 1913. No. Amer.

Eupathithrips bagnalli Morgan, 1929. Honduras.

Eurythrips hindsi Morgan, 1913. No. Amer.

Euthrips tritici var. *bispinosa* Morgan, 1913. No. Amer. = *Frankliniella cephalica* (D. L. Cwfd.). Hood, 1925. Bul. Brook. Ent. Soc. 20(2):72.

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Heliothrips bruneri Morgan, 1929. Cuba = *Hercothrips insularis* Hood, 1927. Hood, 1940. Jour. Ent. So. Afr. 3:37.

Heliothrips braziliensis Morgan, 1929. So. Amer. = *Hercothrips*. Hood, 1940. Jour. Ent. So. Afr. 3:37.

Holopothrips fulvus Morgan, 1929. So. Amer. Hood, 1941. Rev. de Ent. 12(3):583-584.

Horistothrips Morgan, 1913. Genotype: *Horistothrips australiae*.

Horistothrips australiae Morgan, 1913. Australia.

Leptothrips russelli Morgan, 1913. No. Amer. = *Haplothrips fasciculatus* (D. L. Cwfd.). Hood, 1927. Pan-Pacif. Ent. 3(4): 174-175.

Lissothrips (Prolissothrips) stratulus Morgan, 1925a. Puerto Rico.

Microthrips Morgan, 1913. (Genotype: *M. piercei*) = *Leucothrips* Reuter, 1904. Hood, 1931. Pan-Pacif. Ent. 7(4):170.

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Physothrips eucharii Morgan, *nomen nudum*. Bermuda. (MS name only; see H. H. Whetzel, 1923. Rpt. Pl. Path. Jan. 1 to May 31, 1922. Rpt. Bd. Agr. Bermuda 1922, pp. 30-31.

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Rhipiphorothrips Morgan, 1913. Genotype: *Rhipiphorothrips pulchellus*.

Rhipiphorothrips pulchellus Morgan, 1913. Phillipine Is.

Sericothrips portoricensis Morgan, 1925a. Puerto Rico.

Thrips helianthi Morgan, 1913. No. Amer.

Thrips quinciensis Morgan, 1913. No. Amer.

Thrips spinosus Morgan, 1913. No. Amer.

Trichothrips amlipennis Morgan, 1913. No. Amer. = *Treherniella.* Hood, 1931. Pan-Pacif. Ent. 7(4):172.

Trichothrips flavicauda Morgan, 1913. No. Amer.

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Heterothrips salicis Shull, 1909. No. Amer.

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Scirtothrips ruthveni Shull, 1909. No. Amer.

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Horistothrips palidispinosus S. and M., 1930. China.
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Neoheegeria hibisci M. and S., 1933a. Society Is., Moorea.
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Sericothrips dentatus S. and M., 1930. China.
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Plesiothrips andropogoni Watts, 1934a. No. Amer.
Plesiothrips andropogonis var. *watsoni* Watts, 1934a. No. Amer.
Stephanothrips corticinus Watts, 1935. No. Amer.
Stephanothrips fusiantennatus Watts, 1935. No. Amer.

NOTES ON BIOLOGICAL CONTROL IN CUBA

L. C. Scaramuzza, Entomologist, Atlantic Gulf Sugar Company, Mercedes, Province Matanzas writes that he is working on the biological control of the sugar cane borer, *Diatraea saccharalis* F., by means of the artificial multiplication and mass releases of the Cuban Fly, *Lixophaga diatraeae* Towns., of which 44,500 were released last year in six plantations. This is the third year of this project and we have been able to reduce the joint infestation by more than 50 per cent and increase the rate of parasitization by more than 100 per cent.

SUGARCANE BORER BIOLOGICAL CONTROL IN CUBA

Year	Percentage of Infested Joints Average	Total Parasitization Per Cent	Lixophaga Flies Liberated
CENTRAL CONCHITA			
1945	16.4	1.0	7,420
1946	10.1	8.7	16,195
1947	7.9	12.2	13,245
CENTRAL MERCEDES			
1945	No data	1.6	8,397
1946	15.4	6.8	16,331
1947	4.9	17.2	13,441

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Hexachlorocyclohexane (Benzine hexachloride) insecticide, DDT, and sulfur combined in a dust that effectively controls boll weevil, cotton leaf worm, Lygus bugs, cotton flea-hopper, cotton aphids and others.

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An organic fungicide — ferric dimethyl dithiocarbamate; particularly adapted to use as a preventive for diseases affecting fruits, tobacco, greenhouse and ornamental plants, and certain vegetables.

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Ammonium sulfate—for control of hard to kill woody perennial weeds such as poison ivy, sumac, wild blackberry and brush growth; permanently kills most woody weeds.

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Sodium salt of 2, 4-dichlorophenoxyacetic acid—selective weed killer for control of many broad-leaf weeds.

Du Pont 2, 4-D 67% Amine Weed Killer
A liquid salt which is ideal for use in low gallonage applications to control weeds. This liquid form of 2, 4-D mixes very easily with all types of water.

Du Pont 2, 4-D 46% Ester Weed Killer
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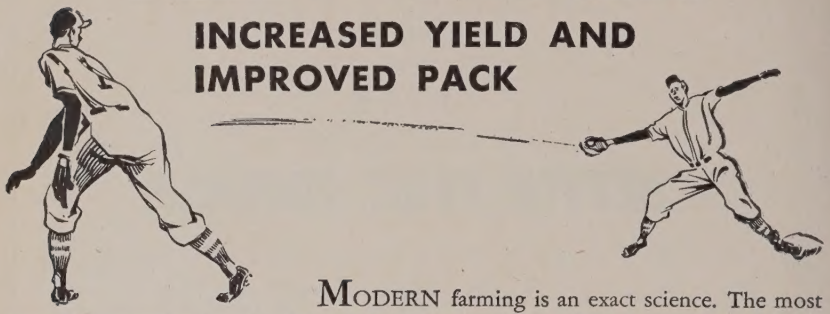

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★ INSECTICIDES
★ FUNGICIDES
Management
Labor

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TECHNICAL DATA

Agricultural Chemical Division
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SYNKLOR

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Japanese Beetle Grubs
Mole-Crickets
Roaches
Serpentine Leaf Miner
Squash Bugs
Ticks—and many plant bugs

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